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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

TOBIAS GERLACH

Serial No.: 10/678,799

Filed: October 3, 2003

For: METHOD FOR DETERMINING THE FREQUENCY OF THE CURRENT RIPPLE IN THE ARMATURE CURRENT OF A COMMUTATED DC MOTOR

Attorney Docket No.: KOA 0242 PUS (R 1415)

Group Art Unit: 2857

Examiner: West, Jeffrey R.

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
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Sir:

This is an Appeal Brief for the appeal of the final rejection of claims 1-3, 6-7, 9-13, and 16-19 of the final Office Action mailed November 2, 2004 for the above-identified patent application.

CERTIFICATE OF MAILING UNDER 37 C.F.R. § 1.8

I hereby certify that this paper, including all enclosures referred to herein, is being deposited with the United States Postal Service as first-class mail, postage pre-paid, in an envelope addressed to: Mail Stop Appeal Brief - Patents, Commissioner for Patents, U.S. Patent & Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 on:

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I. REAL PARTY IN INTEREST

The real party in interest is Leopold Kostal GmbH & Co. KG ("the Assignee"), a corporation organized and existing under the laws of the Federal Republic of Germany, and having a place of business in the Federal Republic of Germany, as set forth in the assignment recorded in the U.S. Patent and Trademark Office on January 12, 2004 at Reel/Frame 014872/0677.

II. RELATED APPEALS AND INTERFERENCES

There are no appeals or interferences known to the Applicant, the Applicant's legal representative, or the Assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

III. STATUS OF CLAIMS

Claims 1-3, 6-7, 9-13, and 16-19 are pending in this application. Claims 4, 8, 14-15, and 20 have been cancelled. The pending claims (claims 1-3, 6-7, 9-13, and 16-19) have been finally rejected and are the subject of this appeal. A copy of the pending claims are reproduced in the attached Claim Appendix. Of the pending claims, claims 1 and 11 are the only independent claims.

IV. STATUS OF AMENDMENTS

The Applicant mailed an Amendment after Final on November 8, 2004. In this Amendment, the Applicant amended claims 1, 6-7, 9-11, and 16-19 to address minor claim objections raised by the Examiner in the final Office Action. In this Amendment, the Applicant also cancelled claim 20. In the Advisory Action mailed November 30, 2004, the

Examiner did not explicitly indicate that these proposed amendments would be entered for purposes of appeal. The Applicant believes that the lack of indication is an oversight and that theese amendments will be entered for purposes of appeal. Accordingly, the copy of the pending claims reproduced in the attached Claim Appendix include these amendments.

V. SUMMARY OF CLAIMED SUBJECT MATTER

1. Independent Claim 1

Independent claim 1 recites a method for determining a frequency of current ripples contained in an armature current signal of a commutated direct current (DC) motor. (The title; page 1, lines 10-12; and page 3, lines 4-19 of the Applicant's specification.)

The method includes determining a frequency spectral result of the armature current signal of the motor in which the armature current signal contains current ripples and interference. (Page 3, line 3 through page 4, line 4; and page 7, line 8 through page 8, line 2 of the Applicant's specification; FIG. 1A (which is a plot of the armature current signal "I" in the time domain); FIG. 1C (which is a plot of the armature current signal "I" in the frequency domain).)

The method further includes determining a frequency spectral result of a voltage signal of the motor in which the voltage signal contains the interference. (Page 3, line 3 through page 4, line 4; and page 7, line 8 through page 8, line 2 of the Applicant's specification; FIG. 1A (which is a plot of the motor voltage signal "U" in the time domain); FIG. 1B (which is a plot of the motor voltage signal "U" in the frequency domain).)

A frequency spectral result of the current ripples contained in the armature current signal is determined based on differences between the frequency spectral result of the

armature current signal and the frequency spectral result of the motor voltage signal such that the determined frequency spectral result of the current ripples contained in the armature current signal is void of frequency components which are superimposed on the armature current signal as the interference. (Page 3, lines 3-19; page 4, lines 5-22; page 6, lines 4-12; and page 8, lines 3-21 of the Applicant's specification; FIGS. 1B, 1C, and 2B in which FIG. 2B illustrates a plot of the determined frequency spectral result of the current ripples ("Frequency Spectrum Current Ripple") which represents the difference between the frequency spectrum plots of FIGS. 1B and 1C (i.e., the difference between the frequency spectrum voltage (U) plot of FIG. 1B and the frequency spectrum current (I) plot of FIG. 1C).)

The frequency of the current ripples contained in the armature current signal is then determined from the determined frequency spectral result of the current ripples contained in the armature current signal. (Page 2, lines 5-7; page 4, lines 5-10; page 8, lines 9-15 of the Applicant's specification; and the current ripple frequency plot in FIG. 2B.)

2. <u>Independent Claim 11</u>

Independent claim 11 is generally similar to independent claim 1. However, the step of "determining a frequency spectral result" as set forth independent claim 11 differs from the corresponding step as set forth in independent claim 1 by reciting that this step is done "without filtering any of the frequency spectral results of the armature current signal and the motor voltage signal."

In detail, independent claim 11 recites a method for determining a frequency of current ripples contained in an armature current signal of a commutated direct current (DC) motor. (The title; page 1, lines 10-12; and page 3, lines 4-19 of the Applicant's specification.)

The method includes determining a frequency spectral result of the armature current signal of the motor in which the armature current signal contains current ripples and interference. (Page 3, line 3 through page 4, line 4; page 7, line 8 through page 8, line 2 of the Applicant's specification; FIG. 1A (which is a plot of the armature current signal "I" in the time domain); FIG. 1C (which is a plot of the armature current signal "I" in the frequency domain).) The method further includes determining a frequency spectral result of a voltage signal of the motor in which the voltage signal contains the interference. (Page 3, line 3 through page 4, line 4; page 7, line 8 of the Applicant's specification; FIG. 1A (which is a plot of the motor voltage signal "U" in the time domain); FIG. 1B (which is a plot of the motor voltage signal "U" in the frequency domain).)

A frequency spectral result of the current ripples contained in the armature current signal is determined based on differences between the frequency spectral result of the armature current signal and the frequency spectral result of the motor voltage signal such that the determined frequency spectral result of the current ripples contained in the armature current signal is void of frequency components which are superimposed on the armature current signal as the interference without filtering any of the frequency spectral results of the armature current signal and the motor voltage signal. (Page 3, lines 3-19; page 4, lines 5-22 ; page 6, lines 4-12; page 8, lines 3-21 of the Applicant's specification; FIGS. 1B, 1C, and 2B in which FIG. 2B illustrates a plot of the determined frequency spectral result of the current ripples ("Frequency Spectrum Current Ripple") which represents the difference between the frequency spectrum plots of FIGS. 1B and 1C (i.e., the difference between the frequency spectrum voltage (U) plot of FIG. 1B and the frequency spectrum current (I) plot of FIG. 1C).)

The frequency of the current ripples contained in the armature current signal is then determined from the determined frequency spectral result of the current ripples contained in the armature current signal. (Page 2, lines 5-7; page 4, lines 5-10; page 8, lines 9-15 of the Applicant's specification; and the current ripple frequency plot in FIG. 2B.)

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1-3, 6, 11-13, and 16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,977,732 issued to Matsumoto ("Matsumoto") in view of U.S. Patent No. 3,935,512 issued to Falk et al. ("Falk") and further in view of U.S. Patent No. 6,038,532 issued to Kane et al. ("Kane").

Claims 7, 9-10, and 17-19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Matsumoto in view of Falk and Kane and further in view of U.S. Patent No. 4,952,854 issued to Periou et al. ("Periou").

VII. ARGUMENT

A. Claims 1-3, 6, 11-13, and 16 are Patentable Under 35 U.S.C. § 103(a) over Matsumoto in view of Falk and further in view of Kane

1. The Claimed Invention

As indicated above, the claimed invention as recited in independent claims 1 and 11 is a method for determining a frequency of current ripples contained in an armature current signal of a commutated DC motor.

The method includes determining (i) a frequency spectral result of the armature current signal of the motor in which the armature current signal contains current ripples and interference; and determining (ii) a frequency spectral result of a voltage signal of the motor in which the voltage signal contains the interference. A frequency spectral result of the current ripples contained in the armature current signal is then determined based on differences between (i) the frequency spectral result of the armature current signal and (ii) the frequency

spectral result of the motor voltage signal such that the determined frequency spectral result of the current ripples contained in the armature current signal is void of frequency components which are superimposed on the armature current signal as the interference. The frequency of the current ripples contained in the armature current signal is then determined from the determined frequency spectral result of the current ripples contained in the armature current signal.

2. Matsumoto, Falk, and Kane

A. Matsumoto

The Examiner posited that Matsumoto discloses a method for determining a frequency of current ripples contained in an analog armature current signal of a DC motor (citing col. 6, lines 31-32 and 60) comprising:

determining an armature current signal (citing col. 6, lines 34-37; col. 7, lines 20-21); and

determining a result of the current ripples contained in the armature current signal based on the armature current signal and determining a current ripple frequency from the current ripples contained in the armature current signal, without filtering (citing col. 7, lines 18-21).

As such, the Examiner posited that Matsumoto teaches determining an armature current signal and determining a frequency of current ripples contained in the armature current signal. The Examiner noted that Matsumoto does not include means for removing interference from the armature current signal using a voltage signal that contains the interference.

B. Falk

The Examiner posited that Falk discloses a circuit for the compensation of current interference signals including means for:

determining a useful part of a current signal (citing col. 3, lines 58-66) by sensing a current signal containing a useful part and interference (citing col. 3, lines 1-9);

obtaining a voltage signal that contains the interference (citing col. 3, lines 14-21); and

subtracting the voltage signal from the current signal to result in the current signal void of interference (citing col. 3, lines 30-34).

The Examiner posited that it would have been obvious to modify Matsumoto to include means for removing interference from the armature current signal using a voltage signal that contains the interference because it is well known that an armature current signal contains interference and, as suggested by Falk, the combination would have provided means for removing the interference to improve the detection of the ripple component by distinguishing the part of the signal that is representative of the device operation from disturbances caused by a voltage source (citing col. 1, lines 61-66 of Falk).

As such, the Examiner noted that the modification of Matsumoto and Falk includes subtracting a noise component represented by a voltage signal from an armature current signal to determine the resulting current ripple, but does not teach performing the subtraction digitally by using a Fourier transform. That is, the Examiner appeared to acknowledge that the modification does not teach performing the subtraction in the frequency domain.

C. Kane

The Examiner posited that Kane discloses a signal processing device for cancelling noise in a signal including means for:

sensing an analog signal containing both a useful signal component and a noise component (citing col. 2, lines 38-41);

digitizing the analog signal (citing col. 2, lines 42-44);

determining a frequency spectral result of the digitized signal using a fast Fourier transform (citing col. 2, lines 45-48); and

cancelling the noise component of the signal by subtracting a noise prediction signal (citing col. 3, lines 26-32).

The Examiner posited that it would have been obvious to modify the modification of Matsumoto and Falk to include performing the subtraction digitally using a Fourier transform, as taught by Kane, because Kane suggests a method for frequency analysis that is well known in the art to provide the user with easier mathematical analysis and more accurate analysis due to the signals being better defined in classical mathematical signal processing terms and, as suggested by Kane, provides better interference elimination by completely eliminating the noise through clearly defined spectral frequencies (citing col. 3, lines 28-43).

D. Summary of Matsumoto, Falk, and Kane

As indicated above, the Examiner posited that Matsumoto teaches determining an armature current signal and determining a frequency of current ripples contained in the armature current signal; Falk teaches subtracting i) a voltage signal containing interference from ii) a current signal containing the interference and a useful part in order to obtain the useful part by itself (i.e., to obtain the difference between the two signals); and Kane teaches

determining the difference between two signals using their respective frequency transformations.

3. The Claimed Invention Compared to Matsumoto, Falk, and Kane

The claimed invention generally differs from any combination of Matsumoto, Falk, and Kane in that in the claimed invention a frequency spectral result of the current ripples contained in an armature current signal is determined from differences between (i) a frequency spectral result of the armature current signal of the motor in which the armature current signal contains current ripples and interference and (ii) a frequency spectral result of a voltage signal of the motor in which the motor voltage signal contains the interference such that the determined frequency spectral result of the current ripples contained in the armature current signal is void of frequency components which are superimposed on the armature current signal as the interference.

The frequency of the current ripples contained in the armature current signal is then determined from the determined frequency spectral result of the current ripples contained in the armature current signal. That is, in the claimed invention, differences in the frequency spectral results of (i) the armature current signal of the motor and (ii) a motor voltage signal are used to determine the frequency of the current ripples contained in the armature current signal.

The Examiner posited that Falk discloses obtaining a voltage signal that contains the interference contained in a current signal, and subtracting the voltage signal from the current signal to result in the current signal void of interference. Falk discloses that the voltage signal (u_B) containing the interference is essentially obtained from a monitored current (i) (see col. 3, lines 1-21 of Falk); and the voltage signal (u_B) is subtracted from a current signal (u_i) that is the derivative of the monitored current (i) (see col. 3, lines 22-44 of Falk) to

produce a "resultant superimposed signal, i.e. the useful signal" (see col. 3, lines 45-66 of Falk).

The claimed invention differs from Falk in that in the claimed invention characteristics of two signals (e.g., the armature current signal and a motor voltage signal) based on two different things (e.g., the armature current and a motor voltage) are compared to one another whereas in Falk characteristics of two signals (e.g., the voltage signal (u_B) and the derivative current signal (u_i)) based on the same thing (e.g., the monitored current (i)) are compared to one another. As such, modifying Matsumoto to include means for removing interference from the armature current signal using a voltage signal that contains the interference as taught by Falk does not result in the claimed invention because such a modification would essentially include using a voltage signal that is based on the armature current signal. That is, the modification of Matsumoto as suggested by Falk would result in removing interference from the armature current signal using some form of the armature current signal itself (i.e., using a voltage signal which is based on the armature current signal). In contrast, the claimed invention removes interference from the armature current signal using a motor voltage signal.

As indicated above, the Examiner posited that it would have been obvious to modify Matsumoto to include means for removing interference from the armature current signal using a voltage signal that contains the interference because it is known that an armature current signal contains interference and, as suggested by Falk, the combination would have removed the interference to improve the detection of the ripples by distinguishing the ripples from interference caused by a voltage source (citing col. 1, lines 61-66 of Falk).

However, what Matsumoto and Falk fail to suggest without the benefit of the Applicant's disclosure is where to find such a voltage signal that contains the interference common to the interference contained in the armature current signal and at the same time is

essentially void of contributions resulting from the current ripples contained in the armature current signal. Such a voltage signal is the claimed motor voltage signal. That is, assuming that it is obvious to compare an armature current signal with a "voltage signal" containing the same interference it is not obvious without the benefit of the Applicant's disclosure to compare the armature current signal with a "motor voltage signal" which does indeed contains the interference. That is, the Applicant has discovered that a voltage signal of the motor is suitable for use as a voltage signal which contains the interference common to the interference contained in the armature current signal while at the same time being essentially void of contributions resulting from the current ripples contained in the armature current signal.

In view of the foregoing, claims 1 and 11 are patentable under 35 U.S.C. § 103(a) over Matsumoto, Falk, and Kane. Claims 2-3, 6, 12-13, and 16 depend from one of independent claims 1 and 11 and include the limitations therein. For at least this reason, claims 2-3, 6, 12-13, and 16 are patentable under 35 U.S.C. § 103(a) over Matsumoto in view of Falk and Kane.

B. Claims 7, 9-10, and 17-19 are Patentable Under 35 U.S.C. § 103(a) over Matsumoto in view of Falk and Kane and further in view of Periou

Claims 7, 9-10, and 17-19 depend from one of independent claims 1 and 11 and include the limitations of their respective base claim. For at least this reason, claims 7, 9-10, and 17-19 are patentable under 35 U.S.C. § 103(a) over Matsumoto in view of Falk and Kane and further in view of Periou.

CONCLUSION

In view of the foregoing, the Applicant respectfully requests that the Board rules that claims 1-3, 6-7, 9-13, and 16-19 are patentable under 35 U.S.C. § 103(a) over the cited prior art.

A check covering the fee of $500.00 as applicable under the provisions of 37 C.F.R. § 41.20(b)(2) is enclosed. Please charge any additional fee or credit any overpayment in connection with this filing to our Deposit Account No. 02-3978. A duplicate of this page is enclosed for this purpose.

Respectfully submitted,

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Enclosure - Appendices (7 pages total)

VIII. CLAIM APPENDIX

1. A method for determining a frequency of current ripples contained in an armature current signal of a commutated direct current (DC) motor, the method comprising:

determining a frequency spectral result of the armature current signal of the motor in which the armature current signal contains current ripples and interference;

determining a frequency spectral result of a voltage signal of the motor in which the voltage signal contains the interference;

determining a frequency spectral result of the current ripples contained in the armature current signal based on differences between the frequency spectral result of the armature current signal and the frequency spectral result of the motor voltage signal such that the determined frequency spectral result of the current ripples contained in the armature current signal is void of frequency components which are superimposed on the armature current signal as the interference; and

determining the frequency of the current ripples contained in the armature current signal from the determined frequency spectral result of the current ripples contained in the armature current signal.

2. The method of claim 1 wherein the armature current signal is an analog armature current signal, the method further comprising:

digitizing the analog armature current signal;

wherein determining the frequency spectral result of the armature current signal includes determining the frequency spectral result of the digitized armature current signal.

3. The method of claim 1 wherein:

determining the frequency spectral results of the armature current signal and the motor voltage signal includes using a fast Fourier transform on the armature current signal and the motor voltage signal to determine the frequency spectral results of the armature current signal and the motor voltage signal.

6. The method of claim 1 wherein:

the frequency of the current ripples is determined during a start-up phase of the motor.

7. The method of claim 1 further comprising:

determining rotational speed of a drive shaft of the motor based on the frequency of the current ripples; and

determining rotational position of the drive shaft based on the rotational speed of the drive shaft.

9. The method of claim 7 further comprising:

monitoring the frequency of the current ripples for changes during operation of the motor.

10. The method of claim 9 further comprising:

counting the current ripples contained in the armature current signal; and

modifying the number of counted current ripples as a function of a change in the frequency of the current ripples during the operation of the motor.

11. A method for determining a frequency of current ripples contained in an armature current signal of a commutated direct current (DC) motor, the method comprising:

determining a frequency spectral result of the armature current signal of the motor in which the armature current signal contains current ripples and interference;

determining a frequency spectral result of a voltage signal of the motor in which the motor voltage signal contains the interference;

determining a frequency spectral result of the current ripples contained in the armature current signal based on differences between the frequency spectral result of the armature current signal and the frequency spectral result of the motor voltage signal such that the determined frequency spectral result of the current ripples contained in the armature current signal is void of frequency components which are superimposed on the armature current signal as the interference without filtering any of the frequency spectral results of the armature current signal and the motor voltage signal; and

determining the frequency of the current ripples contained in the armature current signal from the determined frequency spectral result of the current ripples contained in the armature current signal.

12. The method of claim 11 wherein the armature current signal is an analog armature current signal, the method further comprising:

digitizing the analog armature current signal;

wherein determining the frequency spectral result of the armature current signal includes determining the frequency spectral result of the digitized armature current signal.

13. The method of claim 11 wherein:

determining the frequency spectral results of the armature current signal and the motor voltage signal includes using a fast Fourier transform on the armature current signal and the motor voltage signal to determine the frequency spectral results of the armature current signal and the motor voltage signal.

16. The method of claim 11 wherein:

the frequency of the current ripples is determined during a start-up phase of the motor.

17. The method of claim 11 further comprising:

determining rotational speed of a drive shaft of the motor based on the frequency of the current ripples; and

determining rotational position of the drive shaft based on the rotational speed of the drive shaft.

18. The method of claim 17 further comprising:

monitoring the frequency of the current ripples for changes during operation of the motor.

19. The method of claim 18 further comprising:

counting the current ripples contained in the armature current signal; and

modifying the number of counted current ripples as a function of a change in the frequency of the current ripples during the operation of the motor.

IX. EVIDENCE APPENDIX

NONE.

X. RELATED PROCEEDINGS APPENDIX

NONE.